[redacted]

Title: PRODUCTION OF RED AIRFORCE TRAINING EQUIPMENT AT ZEISS, JENA
(Germany, Soviet Zone)

[redacted]

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Engineering-Technical Bureau

Scientific-Technical Bureau 16 (NTB) " " November 1949

Berlin-Karlshorst

Proposal for the Project of an Experimental Training Set A-2

The Engineering-Technical Bureau directs NTB 16 to prepare the project, student training set A-2.

1. [[redacted] Par 5: "Annex 1"]

2. The set will consist of the following:
   a. Cabin of a bimotor airplane with all instruments and controls.
   b. Screen for projection of horizon and locality.
   c. Projector for representation of the motions of the plane and locality during takeoff and landing.
   d. Projector for representing motion of the plane when flying by map (visual orientation).
   e. Instructor's desk for control of the student and for assignment of aerodynamic and kinematic factors affecting the plane's flight.
3. The separate parts of the set will serve for demonstration and training in the following processes:
   a. The cabin will simulate completely an actual plane cabin
   b. The student pilot will have a control stick, pedal, gas controls (sektor gasa), apparatus for landing gear control, handle for regulating the engine and foreflap control.

      In addition, the following will be provided: turn indicator, gyrocompass, artificial horizon, thermometer, landing gear position indicator, speedometer, tachometer, altimeter, climb indicator, etc.

      All of the instruments operate and affect the pilot's or instructor's controls. In the case of a flight in cloudy weather or at night the screen does not show the locality. In this case the gyrocompass and climb indicator respond. At increased engine rpm increased speed is indicated.

At the same time, quantities affecting stick and pedal controls vary with the speed.

Speed is decreased when climbing, increased when diving. Since the falling of the plane cannot be expressed in the trainer critical situations will be simulated by optical or other suitable signals. The instructor may transmit certain problems to the student, to which the student will respond in a suitable manner. For example, the instructor cut out spark plugs, in which case the student will have to change the fuel mixture to clear them.

c. The projector mentioned in 2. c above will project the horizon and locality or airport or landing strip on a screen. Projection of the image will be accomplished by means of a mirror which will rotate and will be connected electrically with the controls.

An ordinary movie projector is used for projection of locality pictures. The movie film used will consist of pictures of a locality taken from an airplane, for example, during a landing. Exposure angle for the film should be 45 degrees greater than the angle of projection with respect to the student's angle of view. The student may then carry out landing maneuvers in which he will be able to deviate plus or minus 20 degrees from the quantities in effect at the time of exposure.

Approach to the ground is secured by means of a special apparatus. Correct landing data is transmitted only to the instructor's desk and only he can follow it by instruments. Signal lamps, in turn, inform the student whether he has performed correctly or not.

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Management, K. Zeiss Co.

I call your attention to the following matters;

1. Without the agreement of the consumer, the Zeiss Co. worked out construction of the pancratic projection apparatus in summer which prevents its being mounted on the projection stand in place of the movie projector.

In the opinion of the consumer, this decision, made independantly on the part of the Company, is completely out of order and does not conform to the decision agreed to previously concerning the interexchangeability of movie projection and pancratic apparatus on the projection stand of the A-1 apparatus.

The pancratic projection apparatus prepared by the Company in 1949 cannot serve as models for serial production.

Please take immediately the necessary steps to adjust your position.

2. Two months ago we approached the company on the matter of supplying for each A-1p apparatus an extra pancratic projector, and with each A-1k apparatus an extra movie apparatus.

The company proposed to supply in addition, 100 projection stands with the movie apparatus and 100 projection stands with the pancratic apparatus.

We don't need any extra projection stands.

3. On 25 November we (NTB-16) sent you two notes. NTB-16 requested from you a report on the period of fulfillment of these two notes. However, to date no such report has been forthcoming.

Please rush report of the terms on the two above-mentioned notes.

Smerkalov

29 November 1949

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Transcript of Conference Proceedings, 30 November, 1949

Place: Jena

Present: Smerkalov and Ratmirov of NTB-16

Dr. Hilgers of the Berlin Engineering Bureau

Schreiber

R. (Rudi) Mueller

Scheibe

K. (Kurt) Mueller

Helmrich

Tele

Dr. Guenot

Case: A-1 Apparatus

Smerkalov expressed surprise that the Zeiss Co., contrary to his wishes made a proposal which provides for the interchange of cine-device for pancrat in such a way that a second complex projection stand with locality projector, mirror device, and sound film movement (or pancrat) must be added to the existing complex projector P (or K); Captain Smerkalov regards such a solution as too expensive.

Smerkalov demands that construction be carried out so that the movie projector alone is replaced by the pancrat. Zeiss must immediately carry out the proposal for the supply, in addition to the 100 A-1P training sets with locality projector and the 100 A-1K sets with locality projector, of 100 P projectors and 100 K projectors, bringing the entire order to 200 cabinets, 200 projection stands with locality projector and mirror apparatus, and in addition, 200 pancrats and 200 movie projectors fitted according to our wishes. The necessary change in construction must be considered by us in the proposal. The matter cannot be settled simply by specifying the price for the additional projectors.

Smerkalov wants to see a sample of the new construction in a minimum of time. Our request for a change in construction to eliminate one

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panorat and one cine device, i.e., to take one half of the models provided for in the 1949 order and turn them over to us for reconstruction, is not fulfilled. In view of this it will be impossible to prepare such a model in 1949. By 31 January 1950, Zeiss must prepare from the 5th apparatus now in the preparatory stage, a new model which will form the basis for formulation of the final decision on the form of the serial (production) apparatus. The design must be drawn up in rough form and turned over to the shop. Electrical diagrams must be supplemented accordingly.

On 30 November, Zeiss turned over to Smerkalov forms, in triplicate, for the acceptance of the A-1K, and requested that acceptance proceedings start as quickly as possible so that there would be opportunity to take final action on any changes desired. Smerkalov establishes the condition that tests started be dependent upon the submission of separate appropriate quarters, for private use.

The more detailed descriptions of the units, which Smerkalov desires, will be prepared by us. To date, the following units have been turned over: O-fan and the potentiometers unit 1, others will follow.

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Director Export Department
Vneshtorg SKK Administration (Foreign Trade Administration)

(1) Berlin-Karlshorst

Stuehlingerstrasse 1

Symbol: ORZ/ElG/Nkr 1/12/49

Case: Order No BT 80/19270 dated 5/9/49

Addendum to our proposal 1/836 005 dated 7/11/49

In accordance with the wishes of the Director, NTB 16 Committee, we submit the following supplementary proposal:

100 movie projectors, replaceable with pancratic projector
100 pancratic projectors, replaceable with movie projector

Granting that the order for these additional 200 projectors is received by us not later than the end of December 1949, these projectors together with 200 A-1 training sets will be supplied in 1950.

Prices under our present proposal are computed on the basis of preliminary calculation in accordance with the status of development as of 1/12/49. In the event that further substantial changes in the apparatus are required, we reserve the right to alter prices. Final accounting will be conducted at the proper time in accordance with the prices approved by the German Price Inspection.

Respectfully,

O P T I K

Karl Zeiss Jena Peoples Enterprise

Planning Dept.

/signed/ Schreiber
Wolfram.

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In the paragraphs below, the following special cases are observed:

fighter action without bank ($\varphi = 0$)

with bank ($\varphi \neq 0$)

a. Banking position zero

It was first assumed that neither rudder nor aileron deviated. In this case sliding contacts g, h, i, j are stable and there is no potential at any of the contacts. Therefore, there is no potential at signal (komandnyy) coil E_2, so that

$$\frac{dy}{dt}_{JP} = 0$$

This agrees with equation (17) part b, if with $\varphi = 0$ and $\eta_s = 0$ during action of the elevator alone, no lateral motion can occur. With elevator deviation η_H, at the upper and lower connections of resistances 1 and 5 (cf. sketch 9, app. 5), the following potentials are obtained:

at 1 - o.... potential $V_d = -\frac{3}{5} \frac{\eta_H}{\eta_{H\,max}} \cdot V_o$

at 1 - u.... potential $V_c = \left(\frac{2}{5} + \frac{3}{5} \frac{\eta_H}{\eta_{H\,max}} \right) V_o$

Sometimes the potential is zero at the upper end of signal coil E_1 and the potential at the lower end is $-\frac{3}{5} \frac{\eta_H}{\eta_{H\,max}} = V_o$.

Consequently, the voltage distributed to signal coil E_1 is

$$V_{e\,1} = + \frac{3}{5} \frac{\eta_H}{\eta_{H\,max}} V_o$$

Since in the given case $\varphi = 0, \eta_s = 0$, equation (16), part b will be

$$\frac{dz}{dt}_{JP} = 76 \cdot 0.10 \cdot \eta_H$$

Consequently the voltage at the signal coil is proportional to elevator deviation. The factor of proportionality is given in such a manner that the determined vertical speed on the screen is a part of the determined signal coil voltage.

With rudder deviation η_s signal coil E_1 is not affected because the voltage on sliding contacts a and d is opposed and equal, as a result of which the voltage at sliding contact h is equal to zero. However, voltage at sliding contact g corresponds at command coil E_2 to the voltage at the point E_2 - o. This voltage is

$$V_b = \frac{\eta_s}{\eta_{s\,max}} \cdot Z \cdot V_o .$$

According to equation (17) part b, it is found that $\frac{d\gamma_{II}}{dt}$ at $\varphi = 0$ increases propotionally with η_s.

b. Inclined position ($\varphi \neq 0$)

We shall now examine the case when the motor M 13 (see introduction to this part) moves sliding contacts g and i according to the cos function, and sliding contacts ~~xx~~ h and j according to the sin function. It is necessary to investigate separately the effect of rudder and elevatör when $\varphi = 0$.

a) Elevator inactive, rudder active

The voltage difference at signak coil E_1 is again determined. The sliding contact is moved by a cam disc in the following manner: if the cam disc is at $\varphi = 0$, the sliding contact must be in the middle of the resistance; i.e., $x = \frac{1}{2}$. (Cf app. 7, diagram 6) If the cam disc is at $\varphi = -90°$, sliding contact h must stand at $x = 0$. Thus the movement x of the sliding contact is

$$x = 1/2\,(1 + \sin\varphi)$$

The potential $V_{h,x}$ appearing at sliding contact h will then be

$$(3a)\qquad V_{h,x} = -\sin\varphi\,\frac{4\cdot\eta_s}{5\cdot\eta_{s\,max}}\cdot Z\cdot V_0$$

For the lower connection point E_1 - u it is necessary to observe the realtionships of the voltage at resistance 1 (see app. 7 diagram 7).

If the cam disc stands at $\varphi = 0$, then the sliding contact i will be at $x = 0$, and with $\varphi = 90°$, it will stand at $x = \frac{1}{2}$. Consequently

$$x = \frac{1 - \cos\varphi}{2}$$

Then the voltage at the sliding contact

$$(4a)\qquad V_{i,x} = (1 - \cos\varphi)\frac{V_0}{5} \qquad (\eta_H = 0)$$

Then, at signal coil E_1 there is established the potential difference

$$(3)\qquad V_{E_1} = V_{i,x} - V_{h,x} = \left(-\frac{4\,\eta_s}{\eta_{s\,max}}\cdot Z\sin\varphi + \cos\varphi - 1\right)\frac{V_0}{5}$$

Since maximum rudder deviation $\eta_{s\,max} = 25°$ and $Z = \frac{1}{2}$, then

$$(3b)\qquad V_{E_1} = (-0.08\cdot\eta_s\cdot\sin\varphi + \cos\varphi - 1)\cdot\frac{V_0}{5}$$

Since the voltage V_{E1} is that which must give the speed $\frac{dz_{Jp}}{dt}$ for $\gamma_H = 0$, there is agreement with equation (16) part b with the lone exception of the general factor of proportionality.**

Control of the sliding contact p in W 14 takes place in such a manner that the resistance W = 0 is matched by the distance s = 180 m between fighter and target, distance s = 1,100 m corresponds to maximum resistance. Consequently the voltage fed to signal coil E_2 is

(10b) $$V_{E_2} = \frac{2V_0 \sin}{s} \quad [?]$$

Since, on the other hand the voltage V_{e2} supplies by impulse the horizontal speed $\frac{dy}{dt}$, according to equation (10b) control of the speed of the target on the screen proceeds according to the prescribed law (equation 19, part b). Here also the superimposing process occurs by means of the two signal coils. Movement to the side is accomplished by motor M 12.

4. Interaction Between Motion of the Fighter and the Target

We shall examine the regulation of the motion of the fighter expressed in Fig 13 appendix 12. When the speed lever is moved, the sliding contact shifts with respect to resistance W 19; thus, minimum voltage is fed to signal coil E_4, which (voltage) is determined by the connected resistance W 27. This resistance is so selected that the speed of the fighter $V = V_{min}$ is obtained. Maximum fighter speed is attained at full voltage. Coil E_4, by means of motor M_4 moves the sliding contact with resistance W 4 which regulates the speed of motor M 15 operating on 110 volts. During movie films, motor M 15 unreels the film at the required speed.

With the pancrat in operation, the running speed of the motor M 14 is regulated in a manner similar to that in which the value for expression of the target is varied.

The giving of the speed of the bomber by impulse is explained in sketch 13 a, appendix 12. When the rotating knob of resistance W 22 is

**) [Note: Pages 8 - 13 (43 - 48), beginning at this point, are missing from the original document.]

50X1-HUM

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III* Kinematics

As already noted, all determinative processes are purely electrical. Consequently, there are no kinematic determinative mechanisms.

With respect to the apparatus, the important kinematic devices are as follows:

a) determinative mechanism for panorat and movie apparatus

b) mirror line for regulating running speed of target image.

c) Sight with a device for indicating point of impact.

a. There is one general mechanism for regulating the speed for both panorat and movie apparatus so that regardless of whether the apparatus is operating with movie or panorat the same running speed corresponds with a single determined electrical signal. The signal unit is the electric motor designated by the letter M in fig. 17, appendix 28. Its running speed is regulated according to the difference between fighter and target speeds. The motor activates four potentiometers P via the mechanism of group A, characterizing, with a 260-degree turn, an approach flight from 1,100 m to 180 m.

The requirement assigned in accordance with the operating conditions of the apparatus is such that the maximum speed of approach would be approximately 150 m/sec. In view of the fact that the electric motor operates at a maximum of about 100 rev/sec. This means that the minimum running time from P for 260° is 1100-180/150 or about 6 seconds, the minimum running time from P for 360° about 8.5 seconds, the maximum running time from M for one revolution about 0.01 second, the relationship of transmission P/M about 850 (total transmission for group A with the transmission relationship of the standard mechanism $1{:}63 = \frac{63 \cdot 80 \cdot 140}{30 \cdot 28} = 840$)

*) [Note: It cannot be determined whether this represents the Russian letter "sh" or the Roman numeral 3.]

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The film drive comes from group A, originating from the mechanism of groupB. There are three groups of films with three different speeds of approach but with identical differences in range. Since each given range must have a potentiometer position --but the film speeds for each group of film must be the same due to limited film-regulating possibility--a thfee-stage alternating mechanism is connected in group B. A normal running time of 20 seconds is required for the shortest film, for a change in range from 900 to 180 m: thus a running time of 25 seconds for 1100 to 180 m. This corresponds to an approach rate of about 36 m/sec. The shaft "F" of the film apparatus which (shaft) brings about transport of the film must have a normal revolution rate of 2.25 rev/sec. Thus we have:

Running time from P at 260° ....about 25 sec

" " " " " 360° .... " 35 sec

each turn of the film roller takes 0.45 sec

ratios of transmission P/F ...79

Connection stage I - $\frac{140.80.100.80.48.75.96.150}{28.30.52.80.72.75.48.64} = 80$

For films with longer running times alternating mechanisms must be used to increase the ratios of the transmission of the filmroller F with respect to the potentiometers and to the running times of the film, so that with the same speed of the film roller, the running time of the potentiometers will be greater.

With running times of 20, 60 and 120 seconds we obtain:

connection stage I, ratio of transmission P/F...80

" II, " 240

" III, " 480

Drive for the pancrat consists of the aggregate of mechanisms A and B. Transmission ratio for group A: $\frac{63.96.88.140}{72.44.28} = 840$

A cam disc is used to run the pancrat. Preliminary drive of the optics takes place within the limit of 260° with a magnification ratio of 1:6 according to a range limit of 1,000 to 180 m. Thus group B has a transmission ratio of:

P/ : 1 [?]

(Potentiometer according to panorat transmission ratio:

$$\frac{140.88.19}{28.44.190} = 1)$$

With respect to the film, it is planned to increase the distance of the approach flight from 1,100 m to 2,200 m. If the length of the film and, consequently, its running time, and also the final range are equivalent, then it will be necessary to increase the fighter's speed of approach to the target by a factor of almost 2.

Wandering of the image on the screen (44) (appendix 25) in horizontal and vertical direction is accomplished via mirrors 35 and 36. With the motor at maximum running speed (100 rev/sec), transmission mechanism operating at 1:63, the rotating speed of the mirror is approximately 2.1° per sec. The angular velocity relative to the observer is inversely proportional to the distance from mirror to projection screen with respect to screen-to-observer distance. Since this last distance is 1,250 mm, the maximum speed of rotation attained by the mirror apparatus is 2.1 · 4,500/1,250 or approximately 7.5° per sec.

The sight and control device for the strike center (SKG) are mounted in one unit. They both have the same determinative mechanisms for establishing the lead angle "α" as a product of target range "S" and angular velocity "ω" of the fighter. In the sight and in the control device for the strike center there are two such mechanisms each for vertical distance "ω_H" [redacted] and for azimuth "ω_S" [redacted]. Data on the angular velocity of each component are transferred to the two corresponding determinative mechanisms in the sight and in the SKG device.

50X1-HUM

SECRET

The distance for the sight is given from the rotating knob on the speed level on the basis of the measurement of the distance from the trainee while the distance for the SKO device originates automatically on the screen through magnification of the target image corresponding to actual distance. The lead angle of the line of sight and the strike center are obtained by the movement of each mirror according to vertical distance and azimuth. The mirror is located in the beam line between the grid and the collimator. If the student makes accurate measurement of the distance the sight point and the control point will always coincide on the screen.

In an additional determinative mechanism there is determined from the wing span (razmakh) "B" of the target plane and from the given distance established by the trainee on the speed lever, the size of the optical measuring ring. "B" is established preliminarily on the rotating knob with the scale on the western (sic) wall of the sight housing. When the diameter of the measuring ring corresponds with the airplane size as visible on the screen, there is also established the correct distance of the target necessary for determining the lead angle.

The principle of range measurement is based on the fact that the measured base, airplane "B", is related to the distance of the target "E" as the diameter of the measuring ring "b" with respect to the focus of the collimator "f". If the span of the target is known and the diameter of the measuring ring is established according to the size of the airplane, this diameter of the measuring ring, by the relationship $E = f \cdot \frac{B}{b}$, is the measure of the distance of the target.

A changeover lever is planned for the sight housing which will allow distance adjustment of the sight at will from 1,000 to 80 or to 0 meters.

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IV 1 a) Kinematic System and Operation of Control Mechanisms

The parts described below, hand and foot controls and speed lever are the mechanisms which change the position of the fighter in flight.

Lateral movement of the hand control in an airplane produces lateral motion to the right or to the left. In the A-1 set this is indicated by turning of the target and locality on the screen to the left or to the right, that is to say, in an opposite manner.

Forward or backward movement of the hand control produces climbing or diving. In the A-1 set, analogously, the target and locality on the screen rise or descend, that is to say opposite to the actual motion of the fighter.

Use of the foot control changes the direction of an airplane to the right or to the left. In the A-1 set, the target and locality on the screen move either right or left.

Use of the speed lever (throttle) increases or decreases the flying speed of the fighter. In the A-1 apparatus this signifies a high or low speed of approach to the target, i.e., slow or fast magnification of the image on the screen--a process which occurs in actuality.

α) Manual Control (Appendix 22)

The manual control (1) with knob (2) is universally attached at point (33) movable to the left or right (azimuthal direction, A-A) at plus or minus 25°, starting from the middle position in the direction of the student (direction B_1) for 15°, from the student (direction B_2) for 30°. Direction A-A corresponds to lateral position of the fighter, direction B_1-B_2 to climb or dive.

Turning manual control 1 in direction A-A turns Y-bracket 3 around axle 4. Bolt 5 with toothed segment 6 is also turned in the same degree. 6 via gear 7 moves sliding contact 8 of potentiometer 9 mounted on corner iron 32. Two cams 10 are mounted on 3 and press on springs 12 via the vessels 11. These springs 12 are located in the housing of springs 31 on corner iron 32. The vessels are supported so that they cannot be moved from the designated zero position by springs 12. The springs 12 have some extra tension. The zero position of the manual control is thus established.

Movement of manual control 1 in the direction B_1-B_2 from Y-bracket 3 turns joint 13 and shaft 14. Toothed segment 15 turns idler 16 and via gear 17 turns gear 18 which meshes with geared countershafts 19 and 20 shifting between the arms 21. 19 and 20 are supplied with two or three sliding contacts which slide around potentiometer 24. For transmission of current sliding contacts 23 are connected with sliding contacts 22 to slide along metal rods 25. Corner iron 32 is connected to joint 13. When shaft 14 turns, the caps 26 and 27, with respect to the vessels 28 loaded by the springs 29 are pressed against spring housing 30. The action of these springs is the same as when the manual control 1 is turned around axle 4 in the direction A-A. Lever 34 from knob 2 activates a push-button switch which causes the strike control point in the sight to flash intermittently.

[Section β), page 72 is a description--similar in scope and nature to that above--of the foot-pedal system, appendix 23.]

[Pages 81,82, and 83 contain descriptions, similar in scope and nature to the above, of the three systems which set up the three types of movement of the image on the screen.]

a) Sight and Control Set for Strike Center (SKG)

On the diagram, looking in the direction of the sight, the sight is on the left and the SKG is on the right. The two devices are in one housing.

1) Sight (appendix 27)

From motor 1 or 2 through mechanism 3 or 4 for azimuth and through gears 5 to 8, rods 13 or 14 are turned around shafts 11 or 12 according to the data on azimuth or altitude, a maximum of 10^{o}.

The detainers 16 limit the action. For sight and SKG there are two rods 13 and 14 to the left and right of the block 15, situated proportionally to the distance to "S"; 1,000 meters corresponds with a course of 22 mm. Knob 67 activates stop lever 68 which limits the travel of block 15 with a course of 3.96 mm corresponding to 180 m of the distance to the target "S". Control 67 can be used to move block 15 to the zero point (fixed sight).

Movement of mirror 23 to change azimuthal direction is accomplished through the system involving rod 21, pin 24, lever 25, gears 26 and 27 and axle 28.

Movement of the mirror to change vertical position uses rod 14 and follows the same system.

2) Range measurement

With the giving of the range quantity which, with the help of a rotating knob at the throttle in the cabin, is transmitted by the movement of bar 32 through a Bowden coupling into the determinative mechanisms, the diameter of the measuring ring 9, consisting of eight points of light and positioned adund cross-hairs, changes according to the quantity "B" of the target plane and its range "s". The measuring ring serves for measurement of range. To do this the student, by using the throttle lever 66 matches the diameter of the measuring ring with the span of the target plane. In the determinative mechanism, by means of lever 34, "B", determined prior to air combat, is set up on a scale (10 to 40 m) and divided by "s" according to the relationship $b \neq f \cdot B/s$, where b is the diameter of the measuring ring and f is the focal distance of the collimator.

Sliding block 35 is moved, corresponding to linear scale "A", proportional to "s". By rotating the B-control 34 another sliding block 36 is set to the "B" scale. Rod C (37) which may be turned and moved on 35 and on 36 sets sliding block 38 on rod D (39), corresponding to the scale for the measuring ring diameter b.

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A-slides are moved from rod 32 via a double-armed lever. The B-slides 36 are moved by shaft 40, connected with 34, which runs along the housing through crank 41 and connecting rod 42.

Slide 38 is connected with conoid 43 which, via pin 45 located on the hinge parallelogram, rod 46, and crank 47, rotates the mounting 48. A glass disc with eight fine spiral apertures illuminated by a lamp bulb rotates in the mounting. The brightness of the lamp is regulated by a resistance on the left wall of the cabin. Adjacent to the disc is a screen with radial apertures with the cross-hairs in the center. Roatation of the first disc on the second, with intersection of the spirals with the radial apertures produces light points with changing diameters which are visible to the student on mirror 23 through collimator 64 and semitransparent mirror 65.

3) Control device for strike center

The sight first receives the angle of lead based on ω and second, the range data. The data ω are obtained from the student's manipulation of the hand or foot control. The range data, with the help of the measuring ring, is determined more or less accurately in view of the correctly-established value of B (target plane wing span). The assigned ω according to altitude and azimuth is fed into the strike center control device in the same quantity as for the sight. However, the data of range "/?/" is always established theoretically correct automatically according to the range actually given from the value of the image. SKG therefore determines without error the angle of lead α.
When the trigger button is pressed there appears on the projection screen a flashing point of light simulating machine gun fire. If this control point is on the target the instructor determines how accurately the student has sighted.

Due to the unusualness of the sight with respect to angular velocity the student when firing, must, by accurate and balanced control of the stick, hold the cross-hairs in the direction of the center of the target.

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50X1-HUM

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Determination of the angle of lead is conducted in the SKG by the same method and with the same elements. The ω elements are supplied at the same value as for the sight. For this reason, both rods 14 for α according to azimuth are joined to the same shaft 12. The rods for α according to altitude are attached to two shafts 11 but are so connected by shaft 52 through rod 6 that they have uniform motion. Block 15 for range, opposite to the sight, is set from spindle 53 which, through rods 54 and 55, is regulated from mechanism 56 which is set in motion by the motor. The running of the motor 57 and consequently of the block 15 proceeds via the potentiometer-transmitter at the movie apparatus or pancrat and the potentiometer-receiver 58 on the drive shaft, so that the motion of the range block is proportional to the length of the film or the equivalent position of the pancrat. Thus the correct range is determined theoretically, and consequently the correct lead angle. Opposite the sight, the light beam from lamp 59 is projected on the screen through the diaphragm 6, [sic] adjustable mirror 61, collimator 62, and fixed mirror 63 which is adjusted to the light point.

[Note: Only the first paragraph on p 91 deals with measuring equipment. The rest of 91 and page 92 are devoted to a description of the chassis assembly.]

Measuring equipment indicates:
- V3: fighter-target distance
- V4: Distance established on the sight by the student
- V5: vertical direction of target
- V6: target azimuth

The Kellog switch SK 1 is used to turn the vertical adjustment mirror ; Kellog switch SK 2 is used to turn the azimuth adjustment mirror. SK 5 shifts the landscape to the left or right. In addition step switches St 2, 3, and 4 are used to weaken or cut out signals by means of hand or foot controls.

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9. Chassis assembly

The welded chassis assembly includes all determinative parts and the current supply. It is possible to assemble these parts outside of the apparatus in the assembly frame and push it under the instructor's seat. Plugs are used for connections with other parts of the appara tus. Parts locations can be seen in appendix 38.

The transformer U 1 in the lower part transforms any circuit voltage into the necessary operating voltage. Next to it are two rectifier columns G [stacks]. On the front are five relays of group E and potentiometer units W 1, 2, and 3. On the back of the front panel are also five group E relays and potentiometer units W 1, 2, and 3. On the back are the group F relays with plug attachment G which by itself is used to transfer the entire apparatus from pancrat to movie operation. To the right on the front is plug St 1 which takes the conductors from projection stand and sight. To the left is St 2 which leads to the fighter's throttle and hand and foot controls. St 3 towards the top on the front is for the desk panel.

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IV Kinematic System of the Set

α) A-1 k (appendix 39)

Main parts:

Forward part of the cabin (1)

Rear part of the cabin (2)

Screen (3)

Movie apparatus (4)

Connecting cable (5)

1) The forward part of the cabin is built as an imitation of an actual airplane cabin, and is covered with sheet metal. The cover 6 may be removed. Under the floor which is raised 25 cm is a three-phase voltage generator with an air blower for cooling 25. On the floor are foot control 15, hand control 17, seat 18, and to the left of the student, the speed control 16. The air blower for cooling the air sets up the air current for cooling the foot and hand control potentiometers which project from under the floor. To the right of the student's seat is a lever 19 for raising and lowering the seat. On the wall in front of the student is a noisemaker 43. To the left of the student on the wall is a blackout resistance 42 for illuminating the sight. The cowl 21 holds the sight, on the left and the strike point control device on the right. The forward part of the cabin 20 has windows. The rear part of the cabin is moved by using the handle on the side. Handle 23 of the speed control is turned to adjust the distance on the sight. The motion is transmitted along a Bowden cable 22. In vertical position, the throttle is on "full"; in an inclined position it is on "slow".

2) The rear part of the cabin may be separated from the forward part. The lower portion is a box 48 with a rear door 8 and two side doors 9. A frame projecting to the rear of the box contains the electrical regulating units. On the box are the instructor's seat 7 and desk 10, with light box for illumination 11.

3) To the front of the cabin there is a frame 31 with the screen 32.

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On the frame are two lamps 30 for illuminating the setup.

4) The movie apparatus consists of a base 34, landscape projector 36, movie apparatus 37 with film drum 46 and mirror housing 47. On the base is a connecting lever which is used in accordance with the length of the film. In the housing are mirrors 38 and 39 for landscape and 40 and 41 for the film.

5) The movie apparatus is connected using double plugs 33 by means of three cables (5).

β) A-1 p (appendix 39a)

Main parts:

Forward part of the cabin (1)

Rear part of the cabin (2)

Screen (3)

Projection apparatus with pancratic optics (4)

1) See preceding section α) 1).

2) See preceding section α) 2).

3) See preceding section α) 3).

4) The projection apparatus with pancratic optics consists of a base 34, projector with pancratic optics 36 and mirror housing 47. The housing contains mirrors 38 and 39 for projection of the target.

5) See preceding section α) 5).

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TABLE NO 16

THE PANCRATIC ERECTOR

08 14 30 - 01 to -04 (5). 08 14 30 01 and 02 (5)

Focal length at 01 is equivalent to f = 80.55 mm ± 0.4 mm 0.5%

" " " 02 " " " " 60.59 mm ± 0.3 mm 0.5%

Groups not included are being used on the optical bench in proportion one to another and the following enlargement values are to be set:

a = 0.3265

b = 0.6097

c = 1.0267

d = 2.0196

The corresponding intersections S_1 and S_2 must have the following values:

a: S_1 = 140.094 mm; S_2 = 41.850 mm

b: S_1 = 92.738 mm; S_2 = 50.050 mm

c: S_1 = 55.125 mm; S_2 = 74.05 mm

d: S_1 = 38.210 mm; S_2 = 116.050 mm

Tolerance of the intersections is ± 0.05 mm

The erectors must be tested, unmounted, on the collimator for 20-x picture enlargement quality in both end positions.

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